ARCADIS
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ARCADIS
35 East Wacker Drive
Suite 1000
Chicago
Illinois 60601
Tel 312.263.6703
Fax 312.263.7897
www.arcadis-us.com

Mr. Michael Wetzel
Environmental Services Superintendent
City of Kalamazoo
1415 North Harrison
Kalamazoo, Michigan 49007

ENVIRONMENTAL

Subject:
Draft Groundwater Evaluation and Work Plan for Supplemental Investigation
Allied Paper, Inc. Operable Unit, OU-1
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Date:
March 6, 2009

Contact:
Tim Scully-Granzeier

Phone:
312.263.6703

Our ref:
B0064587.0000.00006

Dear Mr. Wetzel:

ARCADIS, on behalf of Millennium Holdings, LLC (MHLLC), has provided the attached *Draft Groundwater Evaluation and Work Plan for Supplemental Investigation* (Work Plan) for the Allied Paper, Inc. Operable Unit (Allied OU) to the United States Environmental Protection Agency (USEPA) for review. We are also providing five hard copies for your use. The Draft Work Plan has been developed at the request of the USEPA to provide additional information to address concerns expressed by the City of Kalamazoo, particularly with regard to the potential for polychlorinated biphenyls (PCBs) present at the Allied OU to migrate to the City's drinking water wells.

A teleconference is tentatively planned for the week of March 16, 2009 to receive initial comments. ARCADIS or USEPA will contact the City to coordinate a date for the teleconference. If necessary, a subsequent teleconference or meeting may be held for follow-up discussion. If you would like to comment on this Draft Work Plan, provide written comments to USEPA on or before April 1, 2009

If you have any questions or comments regarding this letter, please contact the undersigned.

Sincerely.

ARCADIS

Tim Scully-Granzeier
Project Manager

Enclosures:

(1) *Draft Groundwater Evaluation and Work Plan for Supplemental Investigation*

Copies:
Michael Berkoff, USEPA
James Saric, USEPA
Paul Bucholtz, MDEQ
Bruce Merchant, City of Kalamazoo
Jeff Spoelstra, Kalamazoo River Watershed Council
Jeff Keiser, CH2MHill
Stephen Weisher, MHLLC

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DRAFT

Mr. Michael Berkoff
Remediation Project Manager
USEPA Region 5
Superfund Division
Remedial Response Section #2
SR-6J
77 W. Jackson Blvd. (SR-6J)
Chicago, IL 60604

ARCADIS
35 East Wacker Drive
Suite 1000
Chicago
Illinois 60601
Tel 312.263.6703
Fax 312.263.7897
www.arcadis-us.com

Environmental

Subject:
DRAFT Groundwater Evaluation and Work Plan for Supplemental Investigation
Allied Paper, Inc./Kalamazoo River/Portage Creek Superfund Site
Allied Paper, Inc. Operable Unit

Date:
March 6, 2009

Contact:
Tim Scully-Granzeier

Phone:
312.263.6703

Our ref:
B0064587.0000.00005

Dear Mr. Berkoff:

ARCADIS, on behalf of Millennium Holdings, LLC (MHLLC), has prepared this *Groundwater Evaluation and Work Plan for Supplemental Investigation* (Work Plan) at the request of the United States Environmental Protection Agency (USEPA). The primary goal of the supplemental work described in this letter is to address concerns expressed by the City of Kalamazoo (the City) in their September 17, 2008 document *Interim Technical Responses to the Allied Paper Operable Unit Kalamazoo, Michigan Remedial Investigation Report* (City of Kalamazoo 2008), particularly with regard to the potential for polychlorinated biphenyls (PCBs) present at the Allied Paper, Inc. Operable Unit (Allied OU) to migrate to the City's drinking water wells. In its document, the City stated that they did not believe this issue was adequately addressed in the Remedial Investigation (RI) Report for the Allied OU, which was finalized by the Michigan Department of Environmental Quality (MDEQ) in March 2008 (MDEQ 2008). Based on the information available to date, including that presented in the RI Report, the weight of evidence does not indicate that a pathway for migration exists, as further supported herein; however, there is uncertainty with respect to potential impacts to the deeper regional aquifer beneath the Allied OU and regional groundwater flow conditions. MHLLC agrees to address these uncertainties prior to finalization of the Feasibility Study (FS) for the Allied OU.

ARCADIS developed this Work Plan and will carry out the activities proposed on behalf of MHLLC because there is agreement among all stakeholders that the City's drinking water wells are a critically important public resource. It is also agreed that the uncertainty by

City and other stakeholders associated with the potential for PCBs at the Allied OU to migrate and impact the City's drinking water wells located northwest of the Allied OU (City's Water Pumping Stations 1, 2, 3, and 7; hereafter referred to as "the City's well field") should be addressed. Figure 1 shows the location of the City's well field in relation to the Allied OU.

This Work Plan summarizes existing information that supported scope development and describes the recommended scope of work. The scope of work includes obtaining an expanded set of water levels, quantitatively evaluating the potential for downward migration of PCBs into the regional aquifer, and qualitatively evaluating the potential fate of PCBs in the environment, relative to site conditions.

Purpose

The purpose of the recommended investigation and evaluation is to reduce uncertainty associated with the potential for the Allied OU to impact the City's well field by further assessing the unlikely migration pathway from the Allied OU to the City wells.

The available data sources provide a foundation for understanding the subsurface at the Allied OU (through the RI Report [MDEQ 2008]) and the regional hydrogeological environment (through the City's groundwater flow model and capture zone analysis [City of Kalamazoo 1999], among other studies). The activity described in this Work Plan is designed to address the potential for the Allied OU to impact the City's well field through an evaluation of the interface, or control surface, between the Allied OU and the surrounding regional system, both vertically and laterally.

ARCADIS evaluated various approaches and data needs relative to assessing the potential for a complete pathway to exist for PCBs to migrate from the Allied OU to the City's well field. Establishing an expanded hydrogeological conceptual model, by providing additional measurement of hydraulic gradients in the vertical and horizontal directions, was selected as a direct method to assess whether the potential exists for Allied OU impacts to affect the City's well field. The primary hypothesis, which the investigation is designed to verify, is that a hydraulic head differential across the low-permeability zone that underlies the Allied OU creates an upward vertical gradient that precludes downward flow from the Allied OU to the lower groundwater zone, which may be in communication with the City's well field. Therefore, synoptic measurement of water levels at strategic locations within and beyond the OU, particularly at the hydrogeologic interfaces, constitutes the focus of this Work Plan. If the recommended hydrogeological analysis demonstrates, by use of hydraulic gradients in a weight-of-evidence approach,

that the shallow groundwater from the Allied OU does not cross these interfaces or control surfaces, it can be reasonably concluded that groundwater at the OU could not impact the City's well field.

The secondary hypothesis, that attenuation mechanisms (i.e. adsorption, dispersion, and degradation) preclude PCB impacts from significant migration in any direction, will be addressed in the evaluation task of the scope of work.

This analysis requires appropriate data collection locations that transgress the interface between the Allied OU and the surrounding regional system. Vertically, the interface is defined by the low-permeability stratum that underlies the Allied OU and extends beyond the OU boundaries. Horizontally, the periphery of the Allied OU, specifically in the northwest direction, represents the interface, or "control surface" between the shallow groundwater at the Allied OU and the City's well field. In developing this plan, ARCADIS identified existing optimally-located well clusters at the Strebor property, located adjacent to the OU in the direction of the City well field. If the Strebor well clusters are of suitable construction and adequate condition, they will be used (along with subsurface data from their installation) to obtain additional potentiometric surface measurements in shallow and deeper aquifer units. If the Strebor wells are not acceptable, other wells in the area and/or new wells will be considered.

Other investigative methods were considered in developing this Work Plan, including sample collection and analysis for constituents of concern, geologic investigation to confirm the presence of the underlying low-permeability zone, and evaluation of general groundwater chemistry at various points across the OU. Each of these approaches may contribute to the understanding of the system; however, individually or collectively, these methods cannot positively conclude the presence/absence of a complete migration pathway. For example, a groundwater sample collected from below the low-permeability zone showing the presence of constituents that are also found on the Allied OU could originate from other sources given the history of industrial, manufacturing, and other activity in the surrounding areas, giving rise to questions of source attribution. If hydraulic gradients do not indicate the potential for migration, additional constituent sampling is unnecessary. Therefore, further assessment – specifically, measurement of groundwater levels, the evaluation of groundwater flow potential across control surfaces of the Allied OU, and qualitative assessment of PCB fate in the environment – was selected as an appropriate approach to meet the objectives of the investigation/ evaluation.

Overview of Existing Information

Over the past 15 years, an extensive series of investigations has been completed at the Allied OU and a robust database has been developed. An overview of existing information that can be drawn on to understand the hydrogeologic environment and the potential for PCB transport in groundwater is presented below.

Hydrogeologic Environment

The unconsolidated materials and groundwater investigated at the Allied OU are within the surficial aquifer (MDEQ 2008), which is subdivided into several transmissive zones that are separated locally by discontinuous confining layers. The lowermost of the transmissive zones of the surficial aquifer is identified in the RI Report as the "Lower Sand." Upward hydraulic gradients relative to Portage Creek have been consistently observed at the OU, and shallow groundwater discharges to Portage Creek. Figure 2 (replicated from Figure 30 of the RI Report [MDEQ 2008]) shows a flow-net constructed along cross-section B-B' (location shown on Figure 1), that passes through the OU. This flow-net indicates predominant lateral radial flow below the waste disposal areas of the OU. Approaching Portage Creek (located on both sides of the cross-section) the flow converges and discharges at Portage Creek.

Based on groundwater flow modeling completed by the City (City of Kalamazoo 1999), the surficial aquifer is separated hydraulically from the underlying regional aquifer by at least one laterally extensive confining unit. As shown on cross-section B" to B' (Figure 3), an aquitard was encountered at the northern extent of the Allied OU (2,200 feet north of the Allied OU disposal units), at an approximate elevation of 730 feet, and a sand/gravel and clay unit that may represent an extension of this unit was also encountered in the southernmost wells that make up the City's well field (81-10 and 81-11, located almost one mile north of the Allied OU disposal units). While this aquitard was encountered below the depth of investigation at the Allied OU, it is believed to be locally continuous below the site based on supplemental sources (Fisher 2008, Bay West 1991). As the Kalamazoo River is approached (moving to the north from the Allied OU), the surficial aquifer and confining unit have been observed to be absent, and the regional aquifer becomes unconfined. This "pinching out" of the confining unit appears to occur well away from the Allied OU disposal areas, at least 2,200 feet, and likely more than 4,500 feet toward the Kalamazoo River. Regional data, including data from wells located at nearby locations, indicate that there is an upward gradient from the regional aquifer to the surficial aquifer.

The above condition serves as a site model describing the assumed groundwater behavior relative to the Allied OU. This Work Plan is designed to verify pertinent elements of the site model.

In their September 17, 2008 comments on the RI Report (City of Kalamazoo 2008), the City expressed a concern that one of the Allied OU well clusters that included a well screened in the Lower Sand member of the surficial aquifer (MW-122A and MW-122B) exhibited an apparent downward gradient. ARCADIS examined this issue and found that groundwater in the surficial aquifer near this well cluster appears to converge toward a transmissive zone located at an intermediate depth screened by nearby well MW-212. This means that when hydraulic head data from shallow well MW-122A, intermediate well MW-212, and deep (Lower Sand) well MW-122B are examined, MW-212 consistently exhibits the lowest hydraulic head; therefore, there is a downward gradient from MW-122A to MW-212 and an upward gradient from MW-122B to MW-212. Furthermore, the surface water elevation of Portage Creek is consistently lower than the water level in each of the wells, indicating flow into the creek. The data collection and evaluation associated with this Work Plan further address the vertical gradient at the OU and the concern that groundwater from the surficial aquifer at the OU may migrate into the regional aquifer unit. The specific conditions at MW-122A and MW-122B will be monitored and evaluated as part of this Work Plan.

Potential PCB Transport

To address the specific concern regarding the potential migration of PCBs in groundwater, the available existing information suggests any potential for PCBs to impact the City's well field is low due to the following considerations.

- PCBs do not readily dissolve in water, preferring to adhere to soil or other solids (MDEQ 2008, Fisher 2008).
- Groundwater samples from the Allied OU generally do not contain actionable PCB concentrations; exceptions are a few instances where a well was screened in close proximity to a layer of PCB-containing paper-making residuals (residuals) (MDEQ 2008).
- Water samples from the influent of the Allied OU leachate collection system generally do not contain detectable levels of PCBs, even though these samples are from water in direct contact with PCB-containing residuals.

- Although PCBs have been present at the Allied OU for more than 50 years, the City's monitoring results show that PCBs have not migrated to the City's drinking water wells. The City conducts routine monitoring, and has not detected PCBs in samples from its drinking water wells. Even in 2008, when more sensitive measurements were conducted, PCBs were not detected (Merchant 2008).

In the 15 years of data collection efforts at the Allied Paper, Inc./Kalamazoo River/Portage Creek Superfund Site, the detection of PCBs in groundwater has generally been limited to areas within the landfill operable units where groundwater is in contact with or in close proximity with PCB-containing materials. The infrequent detection of PCBs in groundwater and the general absence of PCBs in groundwater in wells away from areas with PCB-containing residuals are consistent with the physical/chemical properties of PCBs and equilibrium partitioning principles. PCBs preferentially exist in the sorbed, non-soluble phase and are essentially immobile in the dissolved phase, due to the effects of adsorption and retardation, combined with the high natural organic content of the matrix through which groundwater passes. As described in the April 30, 2008 MDEQ interoffice communication from Brant Fisher to Paul Bucholtz (Fisher 2008): "PCBs in groundwater is tempered in large part by the physiochemical properties of the compound that results in adsorption to solids, principally soil or sediment particles. As a result, the occurrence of PCBs in groundwater levels above the screening criteria is limited." Extensive response actions have been completed at the Allied OU since 1998, including soil and sediment removal, installation of a multi-layer cover system, and groundwater/leachate extraction and treatment. The treatment system was installed in 2000 and is operated continuously to treat water collected by the extraction wells along Portage Creek. No detections of PCBs above Groundwater Surface Water Interface (GSI) Criteria of 0.2 micrograms per liter (µg/L) (set by the MDEQ, RRD Operational Memorandum No. 5, September 30, 2004) have been reported in the influent or the effluent of the treatment system since it was installed.

Information contained in both the 2008 MDEQ RI Report and the Fisher memo suggests that there is not a pathway for PCBs in the Allied OU to the City's well field. In the RI Report, MDEQ concluded that the vertical groundwater gradients between the shallow transmissive zones are upward at the Allied OU (preventing contamination of deeper aquifer zones that may be in connection with the City's well field), and the discharge point for groundwater is Portage Creek (so shallower groundwater flow is to the creek and not downward or off of the property).

Further, Fisher (2008) states that, "It is the opinion of the SWPU [Surface Water Protection Unit] that there is little likelihood of an impact to the public water supply wells in question."

Mr. Fisher also discusses the regional hydrogeology and describes a conceptual model for the Allied OU and surrounding area. He confirms limited instances of PCBs in groundwater, despite PCBs in soils at the Allied OU, and states that groundwater flow patterns presented in the March 2008 RI Report (and depicted in Figure 2, replicated from Figure 30 of the RI report [MDEQ 2008]) showing that the discharge point for the groundwater investigated at the Allied OU is Portage Creek "appear reasonable." Mr. Fisher also notes that "heads in the regional flow system[1] are generally higher than those in the surficial aquifer system, which one can assume precludes, to some degree, the downward migration of contaminants." Mr. Fisher does recommend that since a downward migration pathway cannot be "totally ruled out," additional data should be collected to better define environmental conditions at the Allied OU and further investigate the possibility of a migration pathway from the Allied OU toward the City's well field. Specifically, Mr. Fisher recommends as part of the FS process installation of wells located between Allied OU and the City's well field.

Review of Additional Information

The following additional information is summarized to provide the basis for the scope of work presented in this letter.

City of Kalamazoo Drinking Water Production Well Data

The City of Kalamazoo has periodically analyzed samples of water produced by its well field for PCBs, among other contaminants. Although PCB-containing residuals have existed as a potential source of PCBs to groundwater at the Allied OU for over 50 years, PCBs have never been detected in the City's well field, based on the data made available to ARCADIS. Even during a 2008 sampling event, in which eleven samples of City water were collected and analyzed for PCBs and other chemicals using an analytical procedure with the ability to detect PCBs at a lower concentration than used in previous testing[2], PCBs were not detected in any samples (Merchant 2008). This is direct evidence that PCBs are not reaching the City's well field from the Allied OU even though they have been

[1] The City's well field is inferred to tap this regional flow system, which is interpreted by Mr. Fisher to underlie the surficial aquifer system that was investigated at the Allied OU. Near the City's well field and the Allied OU, the two aquifer systems are interpreted to be separated by a confining unit, which would limit and restrict movement of groundwater between the two aquifers.

[2] This method was capable of detecting individual PCB Aroclor concentrations as low as 0.050 µg/L (50 parts per trillion).

in the environment and used in municipal and industrial applications associated with numerous activities in Kalamazoo, in addition to paper recycling, for over 50 years.

Strebor Property Hydrogeological Investigation Results

The Strebor property, located immediately west of the Allied OU, was the subject of a Remedial Investigation completed in 1991, although PCBs were not a primary constituent of concern. The Remedial Investigation/ Feasibility Study Work Plan (Bay West 1990), the Remedial Investigation/ Feasibility Study for Strebor Inc, (Bay West 1991), and the Draft Remedial Action Plan for Strebor, Inc (Bay West 1993) were obtained and reviewed by ARCADIS. Cross-sections A-A' and B-B' from the 1993 Bay West Draft Remedial Action Plan (included as Attachment 1) show an unconfined surficial aquifer that is approximately 50 to 70 feet thick, underlain by a silty clay confining unit that is approximately 8 to 10 feet thick. Beneath the confining unit is a well sorted, medium to coarse grained sand and gravel unit (interpreted by Bay West to be part of the regional flow system) that is under artesian conditions (i.e., the head in the well is higher than ground surface)[3]. The general agreement among the Strebor cross-sections, the Allied RI Report, and the hydrogeological assessment presented in the Fisher memo provides support for the conclusions of the Allied RI Report (MDEQ 2008).

The locations of three pairs of monitoring wells (MW-36 and 37; MW-38 and 39; and MW-30 and 40) consisting of one well screened in the surficial aquifer system and one well screened in the regional flow system installed on and adjacent to the Strebor property are shown on Figure 1. One of the well pairs is located on the former Strebor property, one well pair is located adjacent to the northern portion of the Allied OU, and the third well pair is located north of Alcott Street and west of Portage Creek on the former Performance Paper Mill property. The well construction information for these wells, prepared by Bay West and included in the 1991 Remedial Investigation Report, is provided as Attachment 2. Evaluation of water levels in the well pairs indicates a strong (potential difference of up to 10 feet) upward hydraulic potential. Water levels were measured in these three well pairs on several occasions and each data set shows a consistent upward gradient. This information is compatible with data presented in the RI Report for the Allied OU (MDEQ 2008), as well as the Fisher memo (Fisher 2008).

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[3] ARCADIS cannot verify the accuracy of these cross-sections and they are not the work product of ARCADIS or MHLLC; rather they are presented as an independent generalized depiction of the subsurface based on data collected during an off-site investigation by others.

Groundwater Flow Model and Capture Zone Delineation for City's Well Field

The Water Pumping Stations 1, 2, 3, 4, & 7, Groundwater Flow Model and Capture Zone Delineations report developed by the City of Kalamazoo and Peerless-Midwest Company, Inc. (City of Kalamazoo 1999) provides relevant information regarding the geology and groundwater movement in the area between the City's well field and the Allied OU.

The report states that the City's production wells are screened in the regional aquifer, and the flow model indicates that the Allied OU resides within the 5-year time-of-travel capture zone of the City's well field. ARCADIS reviewed the flow model assumptions, analysis, and conclusions and identified uncertainties, including: consistency with data collected from the Allied OU, an apparent under-estimation of hydraulic conductivity, the simulation of Portage Creek, and the model grid size near the site. Given these uncertainties, it is possible that groundwater in the regional aquifer below the Allied OU is not captured by the City's well field and, instead, discharges to the Kalamazoo River, which is a "gaining stream," in the same manner the surficial aquifer discharges to Portage Creek. However, for the purpose of designing this Work Plan, ARCADIS will conservatively assume that groundwater in the regional aquifer is captured in the City's well field. Given this assumption and the fact that the objective of this investigation/ evaluation is independent of the time-of-travel assessment, the uncertainties are not directly relevant to the scope of this Work Plan.

Scope of Work

The following Tasks 1 and 2 will be completed in accordance with the standard field procedures and project-specific health and safety procedures:

Task 1 – Well Identification/Evaluation/Installation (if necessary): Three pairs of nested wells will be used to establish the wells recommended in the Fisher memo and evaluate the vertical gradient across the confining unit that underlies the surficial aquifer. The well pairs will be located in a non-colinear arrangement between the Allied OU disposal areas and City's well field, with the deeper well screened in the regional aquifer unit and the shallower well screened in the surficial aquifer unit. Upon review of available information, the three well pairs (MW-36 and 37; MW-38 and 39; and MW-30 and 40) installed by others during investigative activities at the Strebor property west of the Allied OU meet the criteria described above. Spatially, these wells are appropriately located at the northwest periphery between the Allied OU disposal areas and the City's well field (Figure 1). Vertically, they are appropriately screened to evaluate the hydrogeologic relationship between the regional and surficial

aquifer units. If further inspection indicates these existing wells are not in suitable condition to meet the investigation objectives, or if access to these wells cannot be readily obtained, then MHLLC will work with USEPA, MDEQ, and the City of Kalamazoo to consider other wells in the area and/or new wells.

Task 2 -- Water Level Measurements: To observe (1) the gradient in the regional aquifer (local scale), (2) the gradient between the regional aquifer and the surficial aquifer, and (3) the gradient within the surficial aquifer relative to water levels in Portage Creek, water level data/ potentiometric surface data will be collected in one synoptic round from:

- Strebor monitoring well pairs MW-36 and 37; MW-38 and 39; and MW-30 and 40 (if suitable and accessible)
- Strebor non-paired surficial aquifer monitoring wells: MW-1, MW-7, MW-15, MW-21, MW-24, and MW-41 (if suitable and accessible)
- Allied OU monitoring wells (accessible monitoring wells at the OU)
- Allied OU stream gauges SG-1 and SG-2 and Alcott Street Dam

Prior to starting work, ARCADIS will obtain an access agreement for the existing (or new) off-site wells and will verify that all wells to be gauged and sampled are accessible and in acceptable condition. ARCADIS will request USEPA's assistance in obtaining access if necessary. As needed, the measuring points will be re-surveyed if the elevation datum used cannot be verified.

Task 3 -- Desktop Review: An updated literature review will be completed to evaluate available regional hydrogeologic data. This will include integrating newly collected data and information from the City's flow model to better understand the relationships between the site and the regional system. This task will also explore flow patterns beyond the influence of the City's well field as they may pertain to the Allied OU.

Task 4 -- Evaluation and Reporting: The evaluation task will involve integrating the historic and newly-acquired information into a cohesive groundwater Conceptual Site Model (CSM) that addresses both the transport mechanisms governing groundwater flow and other processes affecting the fate of PCBs in the environment. Upon review of the water level measurements and the supplemental data evaluation, conclusions

regarding the presence or absence of a groundwater pathway from the Allied OU to the City's well field will be revisited.

If USEPA determines that the results confirm prior conclusions and adequate information exists for preparation of the FS, MHLLC will proceed with the FS activities using the existing hydrogeologic assumptions presented in the March 2008 RI Report. If USEPA determines the supplemental investigation/ evaluation results do not corroborate the general hydrogeologic assumptions for the OU and that available information is inadequate for preparation of the FS, then MHLLC will work with USEPA and MDEQ to further evaluate the observed conditions and continue to evaluate/ address groundwater as a potential PCB migration pathway. MHLLC understands that if the current hydrogeologic assumptions are not supported and there is a need to modify the conceptual model of potential PCB migration, further investigation may be necessary.

Following data collection and evaluation, ARCADIS will prepare and submit a letter report summarizing the results of the activities described in this Work Plan.

Closing

If you have any questions or comments regarding this Work Plan, please contact the undersigned.

Respectfully Submitted,

ARCADIS

Lisa Coffey
Project Hydrogeologist

Tim Scully-Granzeier
Project Manager

Enclosures (3):
Figures
Attachment 1
Attachment 2

Copies:
James Saric, USEPA
Paul Bucholtz, MDEQ
Jeff Kelser, CH2MHILL

Steve Weishar, MHLLC
Michael J. Erickson, P.E., ARCADIS

References

Bay West. 1990. *Remedial Investigation/Feasibility Study Work Plan.* June 1990.

Bay West. 1991. *Remedial Investigation/ Feasibility Study* for Strebor Inc. July 1991.

Bay West. 1993. *Draft Remedial Action Plan* for Strebor, Inc. October 1993.

City of Kalamazoo. 2008. *Interim Technical Responses to the Allied Paper Operable Unit Kalamazoo, Michigan Remedial Investigation Report.* September 17, 2008.

City of Kalamazoo and Peerless-Midwest Company, Inc. 1999. *The Water Pumping Stations 1, 2, 3, 4, & 7, Groundwater Flow Model and Capture Zone Delineations Report.* November, 1999.

Fisher, B. 2008. MDEQ interoffice communication from Brant Fisher to Paul Bucholtz. April 30, 2008.

MDEQ. 2004. RRD Operational Memorandum No. 5. September 30, 2004.

MDEQ. 2008. *Remedial Investigation Report for the Allied Paper, Inc. Operable Unit.* March 2008.

Merchant, B. 2008. Data transmittal via e-mail from Bruce Merchant (City of Kalamazoo) to Michael Berkoff (USEPA) and Suda Arakere (MHLLC). September 29, 2008.

FIGURES

SYR-90 MTK JCR KEW
KRSG - Allied OU (B0064587.0000.00002)
Q:\KRSG\WaterWellLocations\AlliedOU\mxd\CrossSectionLocationMap.mxd - 3/3/2009 @ 4:12:44 PM

NOTES:

1. ALL WELL LOCATIONS ARE APPROXIMATE.
2. CITY WELL LOCATIONS PROVIDED BY THE CITY OF KALAMAZOO DEPARTMENT OF PUBLIC SERVICES ENVIRONMENTAL SERVICES DIVISION.
3. SITE WELL LOCATIONS WERE EXTRACTED FROM FIGURES IN THE 2003 REMEDIAL INVESTIGATION REPORT FOR ALLIED OU PREPARED BY BLASLAND, BOUCK & LEE, INC.
4. STREBOR PROPERTY WELL LOCATIONS WERE DIGITIZED FROM A FIGURE CREATED IN 1993 BY BAY WEST, INC.

LEGEND:

- CITY MONITORING WELL
- CITY PRODUCTION WELL
- STREBOR PROPERTY WATER TABLE MONITORING WELL
- STREBOR PROPERTY INTERMEDIATE MONITORING WELL
- STREBOR PROPERTY DEEP MONITORING WELL
- STREBOR PROPERTY RECOVERY WELL
- ALLIED PAPER, INC. OPERABLE UNIT BOUNDARY (APPROXIMATE)
- PORTAGE CREEK CENTERLINE (APPROXIMATE)
- LINE OF CROSS SECTION

0 700 1,400 Feet
GRAPHIC SCALE

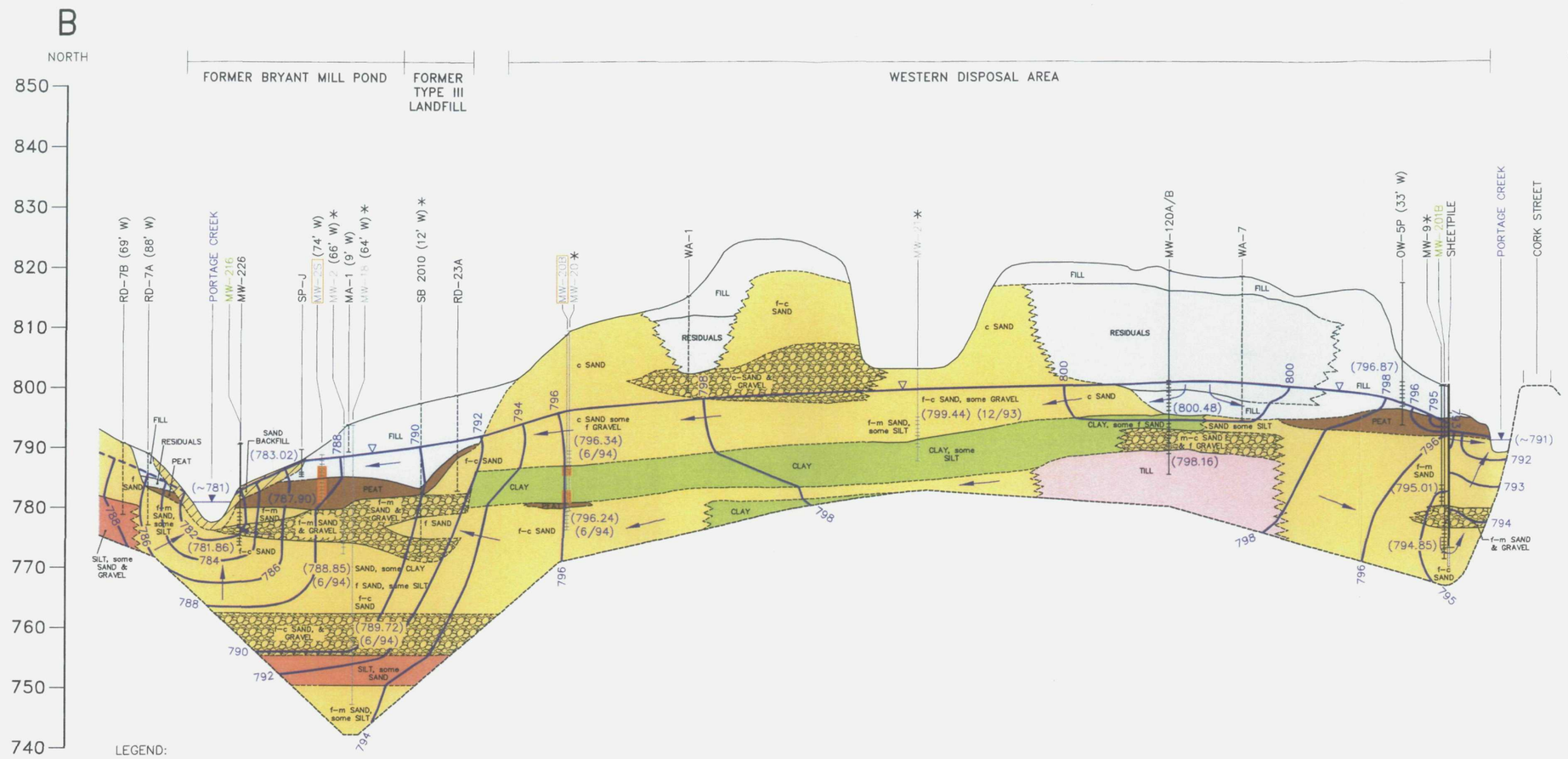
DRAFT

KALAMAZOO RIVER STUDY GROUP
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE

CROSS-SECTION LOCATION MAP

ARCADIS

FIGURE 1



LEGEND:

MW-10	SOIL BORING/SINGLE-CASED WELL
MW-205B	DOUBLE-CASED WELL
MW-2S	BORING/WELL LOCATION WITH GEOTECHNICAL SAMPLE(S) COLLECTED AND ANALYZED
GV-09	GAS VENT

- * — NOT CONTINUOUSLY SAMPLED. SAMPLED AT 5 FOOT INTERVALS.
- MW-1 (11' E) — DISTANCE AND DIRECTION FROM WHICH BORING/WELL IS PROJECTED ONTO SECTION LINE (IF GREATER THAN 10 FEET)
- MW-1 — BORING/WELL ID
- APPROXIMATE SURFACE WATER ELEVATION
- WATER TABLE 6/19/03 (DASHED WHERE INFERRED)
- GAS VENT
- PERMANENT SUMP
- SHEET PILE (SEE NOTE 6)
- SOIL BORING
- ABANDONED MONITORING WELL
- MONITORING WELL
- GEOTECHNICAL SAMPLE INTERVAL
- (796.24) — SCREENED INTERVAL AND HYDRAULIC HEAD, 6/19/03, UNLESS OTHERWISE NOTED
- BOTTOM OF BORING
- 796 — EQUIPOTENTIAL LINE (FEET, AMSL) (CONTOUR INTERVAL AS SHOWN)

- FILL: CONSISTS CHIEFLY OF A HETEROGENEOUS MIXTURE OF SAND AND SILT WITH VARIABLE AMOUNTS OF GRAVEL AND OCCASIONAL DISCONTINUOUS INTERVALS OF REWORKED PEAT. MAY CONTAIN TRACE AMOUNTS OF RESIDUALS.
- SAND BACKFILL: EXTENT (VERTICAL & HORIZONTAL) OF SAND BACKFILL PLACED FOLLOWING THE USEPA'S REMOVAL ACTION AT THE FORMER BRYANT MILL POND IS BASED ON A REVIEW OF THE FINAL REPORT (WESTON, 2000). TOTAL DEPTH OF EXCAVATION WAS NOT PROVIDED WITHIN THE REPORT.
- RESIDUALS: RESIDUALS MAY CONTAIN THIN LAYERS OF SAND OR OTHER FILL.
- PEAT: DEPOSITS OF POST-GLACIAL AGE CONSISTING OF PEAT OR ORGANIC-RICH SILT OR CLAY.
- SAND: PREDOMINANT GRAIN SIZE OF SAND SHOWN AS *FINE [f], MEDIUM [m], OR COARSE [c]*. MAY CONTAIN SMALL AMOUNTS OF CLAY, SILT, OR GRAVEL.
- GRAVEL: GRAVEL MAY CONTAIN SMALL AMOUNTS OF f-c SAND, SILT AND CLAY.
- CLAY: CLAY MAY CONTAIN SMALL AMOUNTS OF f-c SAND AND SILT.
- SILT: SILT MAY CONTAIN SMALL AMOUNTS OF f-c SAND AND CLAY.
- TILL: A GENERALLY HARD DEPOSIT WITH LITTLE OR NO SORTING AND CONSISTING CHIEFLY OF f SAND, SILT, AND/OR CLAY IN VARYING PROPORTIONS, WITH LESSER AMOUNTS OF m-c SAND AND GRAVEL. MAY CONTAIN OCCASIONAL, DISCONTINUOUS LENSES OF SILT, SAND, AND/OR GRAVEL.

NOTES:

1. SURFACE-WATER ELEVATIONS ARE APPROXIMATE.
2. DASHED LINES BETWEEN UNITS REPRESENT INFERRED BOUNDARIES.
3. SURFACE ELEVATIONS FROM TOPOGRAPHIC MAPPING BY LOCKWOOD MAPPING, INC., AND MONITORING WELL/BORING SURVEY DATA.
4. AMSL = ABOVE MEAN SEA LEVEL (NGVD OF 1929).
5. THE DASHED PORTION OF THE SHEET PILE ILLUSTRATES THE HIGHEST AND LOWEST DRIVEN DEPTH OF THE PILING WITHIN 20 FT. OF EITHER SIDE OF THE LINE OF SECTION. THE HORIZONTAL LINE DEPICTS THE DRIVEN DEPTH OF THE SHEET PILE ALONG THE LINE OF SECTION.
6. GROUNDWATER ELEVATION FOR SP-J MEASURED ON 6/20/2003.

DRAFT

10' 0 10' 20'
VERTICAL SCALE

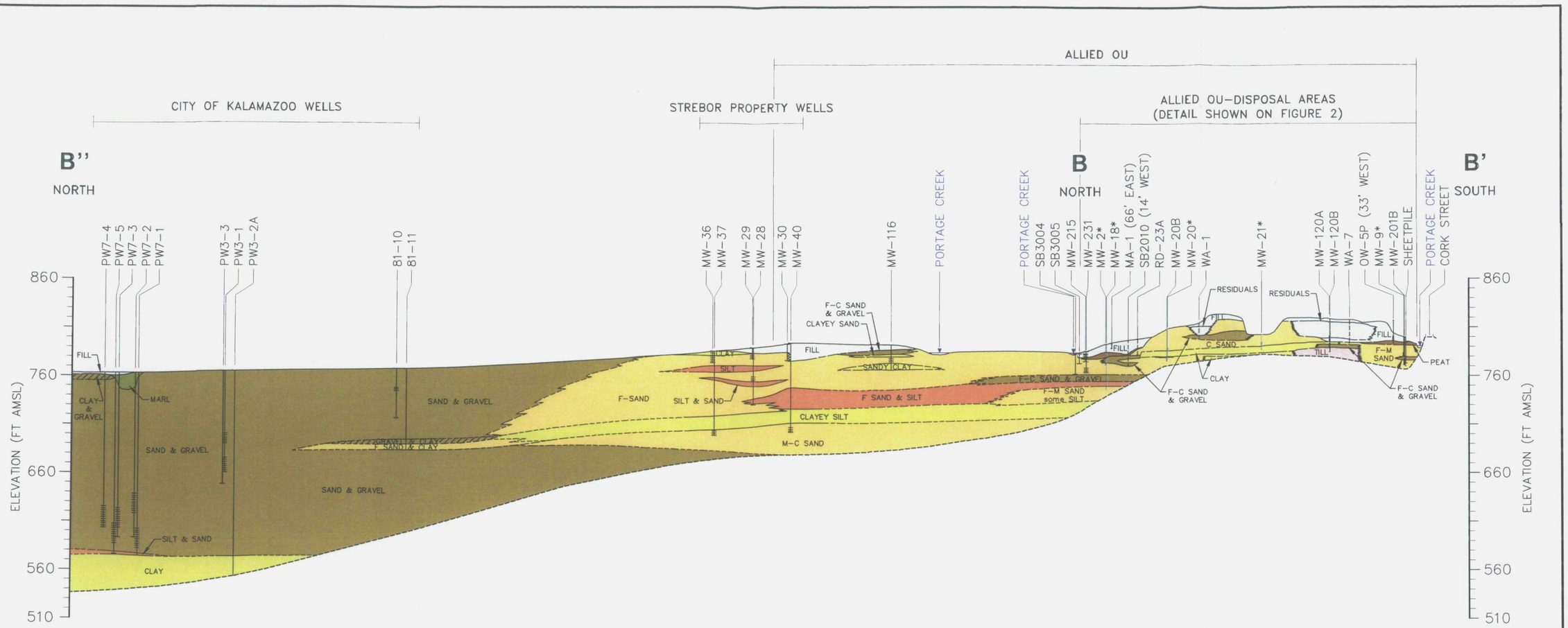
100' 0 100' 200'
HORIZONTAL SCALE

KALAMAZOO RIVER STUDY GROUP
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GEOLOGIC CROSS SECTION B-B'
GROUNDWATER FLOWNET JUNE 19, 2003

ARCADIS

FIGURE 2



NOTES:

1. DASHED LINES BETWEEN UNITS REPRESENT INFERRED BOUNDARIES..
2. SURFACE ELEVATIONS FROM TOPOGRAPHIC MAPPING BY LOCKWOOD MAPPING, INC., AND MONITORING WELL/BORING SURVEY DATA.
3. AMSL = ABOVE MEAN SEA LEVEL (NGVD OF 1929).

FILL: CONSISTS CHIEFLY OF A HETEROGENEOUS MIXTURE OF SAND AND SILT WITH VARIABLE AMOUNTS OF GRAVEL AND OCCASIONAL DISCONTINUOUS INTERVALS OF REWORKED PEAT. MAY CONTAIN TRACE AMOUNTS OF RESIDUALS.

RESIDUALS: RESIDUALS MAY CONTAIN THIN LAYERS OF SAND OR OTHER FILL.

SAND AND GRAVEL: INTERBEDDED SAND AND GRAVELS, MAY CONTAIN SMALL AMOUNTS OF SILT AND CLAY.

MARL: UNCONSOLIDATED DEPOSITS OF CLAY AND CALCIUM CARBONATE.

PEAT: DEPOSITS OF POST-GLACIAL AGE CONSISTING OF PEAT OR ORGANIC-RICH SILT OR CLAY.

SAND: PREDOMINANT GRAIN SIZE OF SAND SHOWN AS FINE [f], MEDIUM [m], OR COARSE [c]. MAY CONTAIN SMALL AMOUNTS OF CLAY, SILT, OR GRAVEL.

CLAY: CLAY MAY CONTAIN SMALL AMOUNTS OF f-c SAND AND SILT.

SILT: SILT MAY CONTAIN SMALL AMOUNTS OF f-c SAND AND CLAY.

TILL: A GENERALLY HARD DEPOSIT WITH LITTLE OR NO SORTING AND CONSISTING CHIEFLY OF f SAND, SILT, AND/OR CLAY IN VARYING PROPORTIONS, WITH LESSER AMOUNTS OF m-c SAND AND GRAVEL. MAY CONTAIN OCCASIONAL, DISCONTINUOUS LENSES OF SILT, SAND, AND/OR GRAVEL.

GRAVEL AND CLAY

LEGEND:

SB2010 (14' WEST)*

- * NOT CONTINUOUSLY SAMPLED. SAMPLED AT 5 FOOT INTERVALS.
- (14' WEST) DISTANCE AND DIRECTION FROM WHICH BORING/WELL IS PROJECTED ONTO SECTION LINE (IF GREATER THAN 10 FEET)
- SB2010 BORING/WELL ID
- SOIL BORING
- ABANDONED MONITORING WELL
- MONITORING WELL
- SCREENED INTERVAL
- BOTTOM OF BORING

DRAFT

0 100' 200'
VERTICAL SCALE

0 600' 1200'
HORIZONTAL SCALE

KALAMAZOO RIVER STUDY GROUP
ALLIED PAPER, INC. / PORTAGE CREEK /
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GEOLOGIC CROSS SECTION B"-B'

ARCADIS

FIGURE 3

ARCADIS cannot verify the accuracy of these cross-sections and they are not the work product of ARCADIS or MHLLC. They are reproduced for this Work Plan to present a generalized interpretation, by Bay West, of the subsurface based on data collected during an off-site investigation conducted by Bay West.

STREBOR INC.
KALAMAZOO, MICHIGAN

INGSTER AVE.
SUPERIOR AVENUE
ALCOTT STREET
STREBOR Inc.
CONSOLIDATED RAIL CORPORATION
REDKER-YOUNG HOLDINGS-LTD (DEMOLISHED)
ALLIED PAPER/ HM HOLDINGS PROPERTY
POLE BARN
WATER TANK
DAM
PORTAGE CREEK
PORTAGE CREEK

A
A'
B
B'
C
C'

MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
MW-11
MW-12
MW-13
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MW-38
MW-39
MW-40
MW-41
MW-42
MW-101
MW-102
MW-103
MW-104
MW-115
MW-116
RW-1
RW-2
RW-3
GMS-1
GMS-2
GMS-3
GMS-4
GMS-5
GMS-6

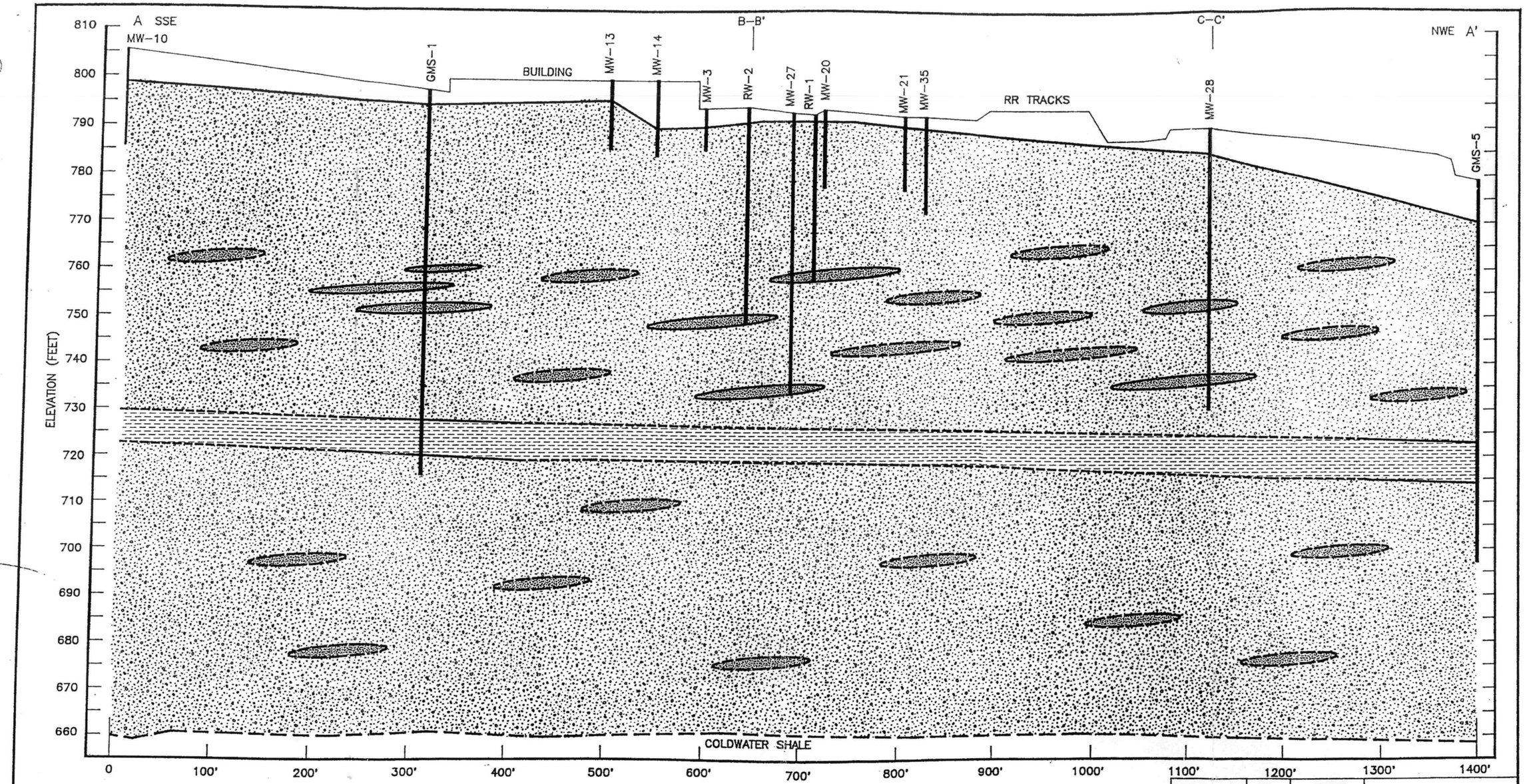
LEGEND

- FENCE
- STREBOR PROPERTY LINE
- WATER TABLE MONITORING WELL LOCATION
- INTERMEDIATE MONITORING WELL LOCATION
- DEEP MONITORING WELL LOCATION
- ALLIED CORP. MONITORING WELL LOCATION
- RECOVERY WELL LOCATION
- GEOPHYSICAL MONITORING STATION
- CROSS-SECTION LOCATION

0 120'

N

ENG'G M. W.	DATE	BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.	
DRAWN K. M.	6/23/91		
REV.	2/22/93		
PROJECT NAME	STREBOR, INC.		
TITLE	GEOLOGICAL CROSS-SECTION LOCATION MAP		
DWG. NO.	7095-SA	SCALE	FIGURE # 6

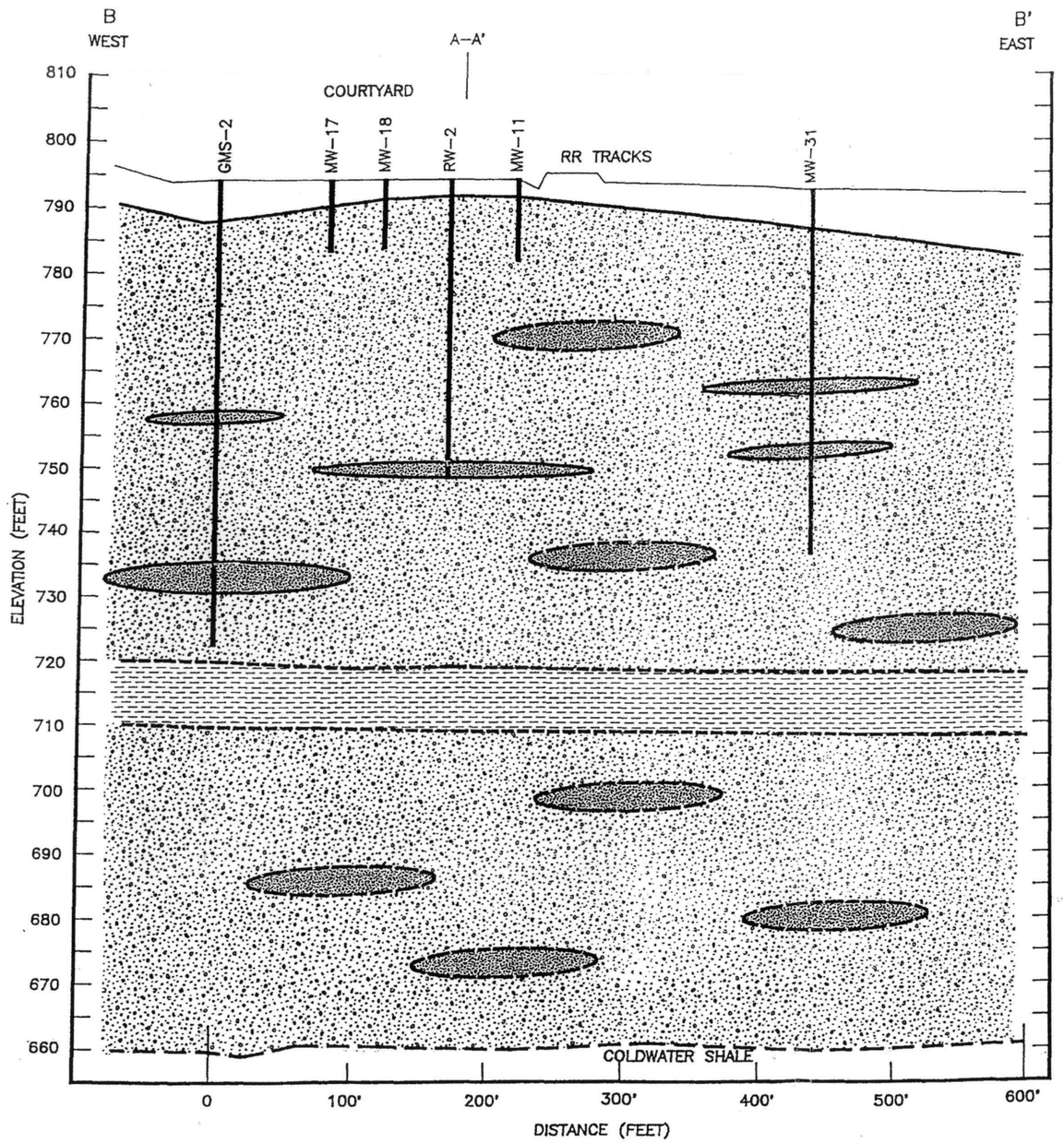


LEGEND:

- FILL
- SAND
- SILTY CLAY / CLAYEY SILT
- SILTY CLAY DIAMICTON

ARCADIS cannot verify the accuracy of these cross-sections and they are not the work product of ARCADIS or MHLLC. They are reproduced for this Work Plan to present a generalized interpretation, by Bay West, of the subsurface based on data collected during an off-site investigation conducted by Bay West.

ENGR'G M.W.	DATE		BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.
DRAWN K.M.	1/23/91		
REV.			
PROJECT NAME	STREBOR, INC.		
TITLE	GEOLOGIC CROSS-SECTION A-A'		
DWG. NO.	1339-B1	SCALE	FIGURE # 7

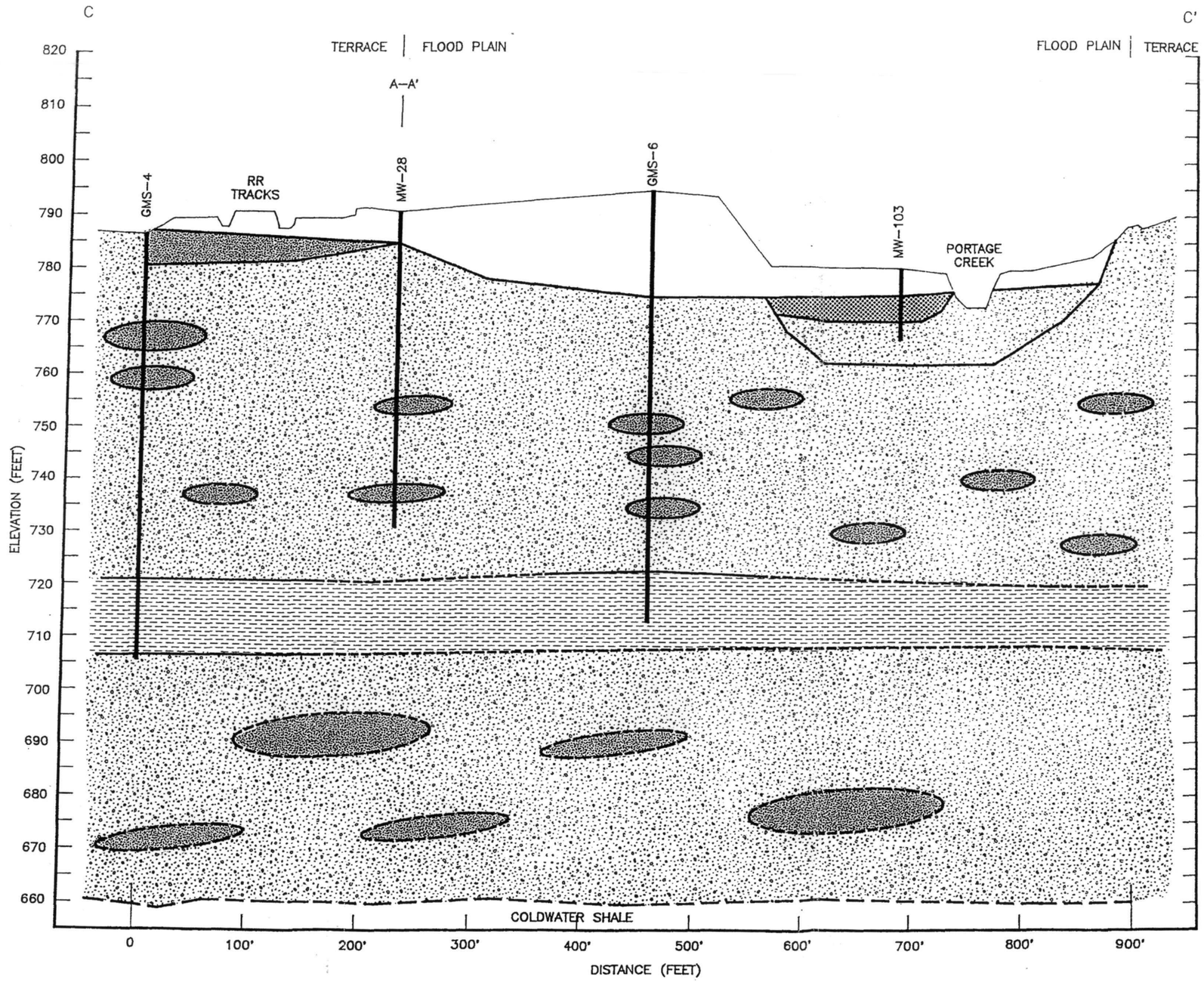


LEGEND:

- FILL
- SAND
- SILTY CLAY / CLAYEY SILT
- SILTY CLAY DIAMICTON

ARCADIS cannot verify the accuracy of these cross-sections and they are not the work product of ARCADIS or MHLLC. They are reproduced for this Work Plan to present a generalized interpretation, by Bay West, of the subsurface based on data collected during an off-site investigation conducted by Bay West.

ENGR'G M.W.	DATE	BAY WEST Inc.	
DRAWN K.M.	1/24/91	ENVIRONMENTAL SERVICES ST. PAUL, MN.	
REV.			
PROJECT NAME	STREBOR, INC.		
TITLE	GEOLOGIC CROSS–SECTION B–B'		
DWG. NO. 1339–B2	SCALE	FIGURE # 8	

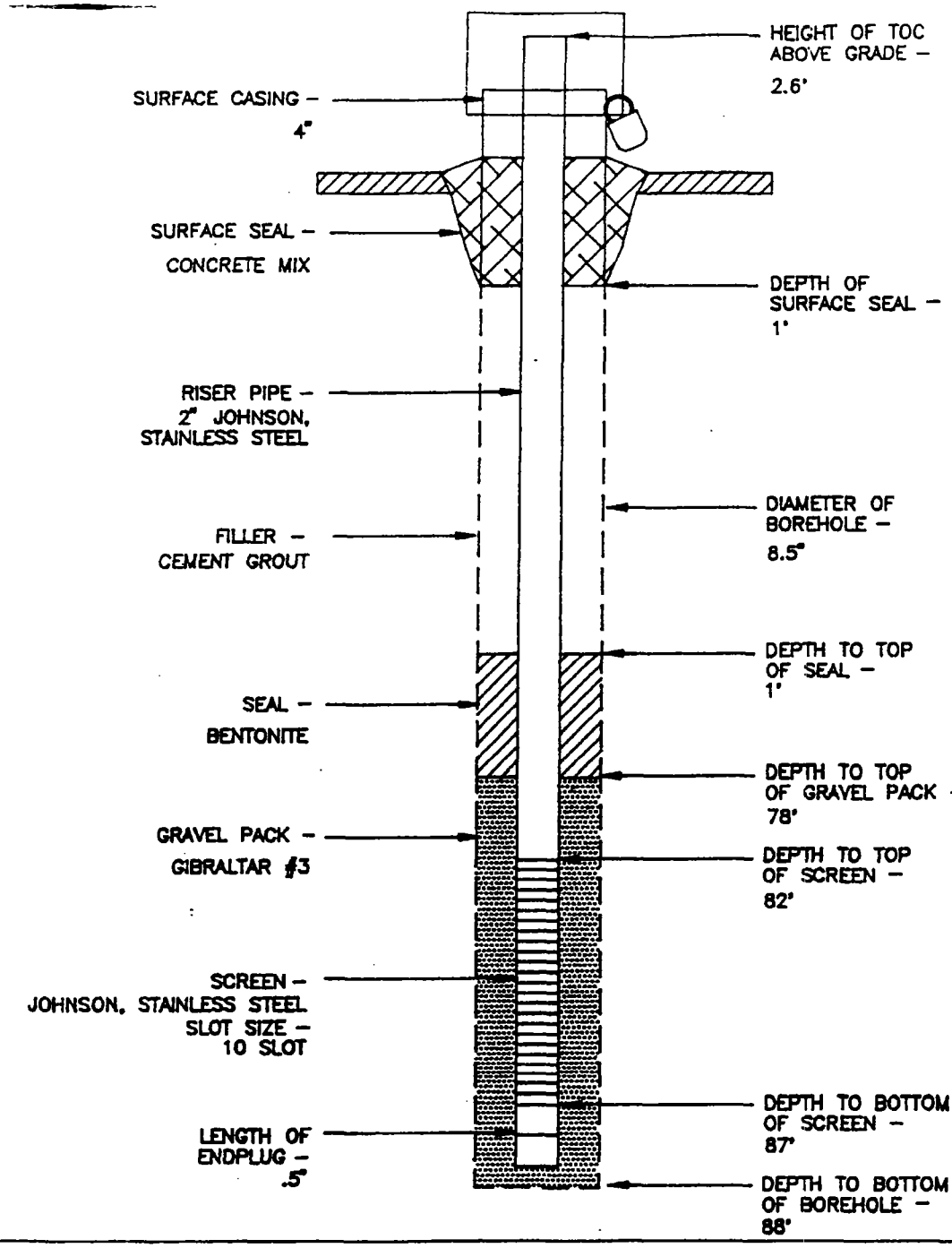


LEGEND:

- FILL
- SAND
- SILTY CLAY / CLAYEY SILT
- SILTY CLAY DIAMICTON
- PEAT

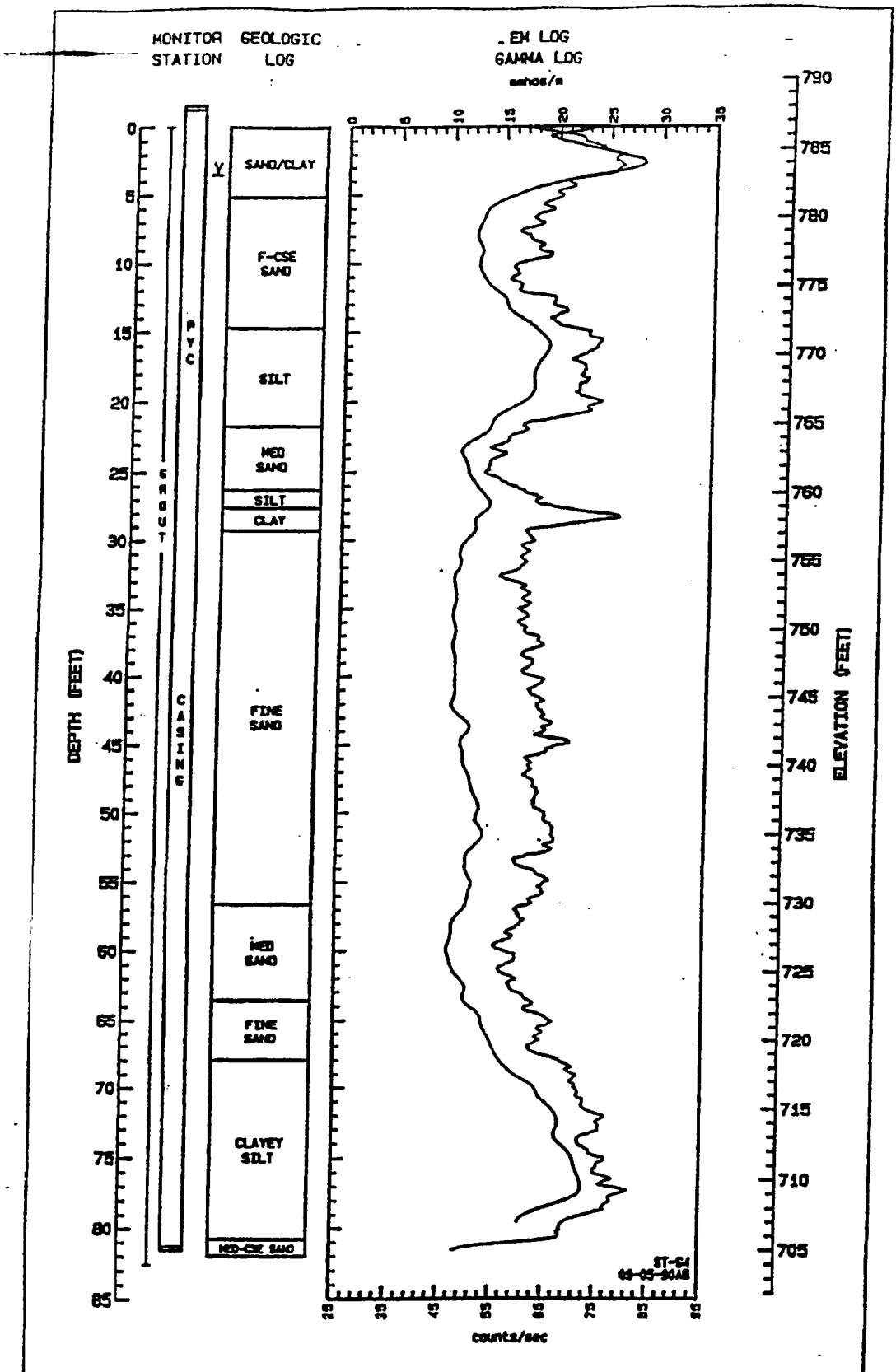
ARCADIS cannot verify the accuracy of these cross-sections and they are not the work product of ARCADIS or MHLLC. They are reproduced for this Work Plan to present a generalized interpretation, by Bay West, of the subsurface based on data collected during an off-site investigation conducted by Bay West.

ENGR'G M.W.	DATE	BAY WEST Inc.	
DRAWN K.M.	1/24/91	ENVIRONMENTAL SERVICES	
REV.		ST. PAUL, MN.	
PROJECT NAME	STREBOR, INC.		
TITLE	GEOLOGIC CROSS–SECTION C–C'		
DWG NO. 1339–B3	SCALE	FIGURE # 9	

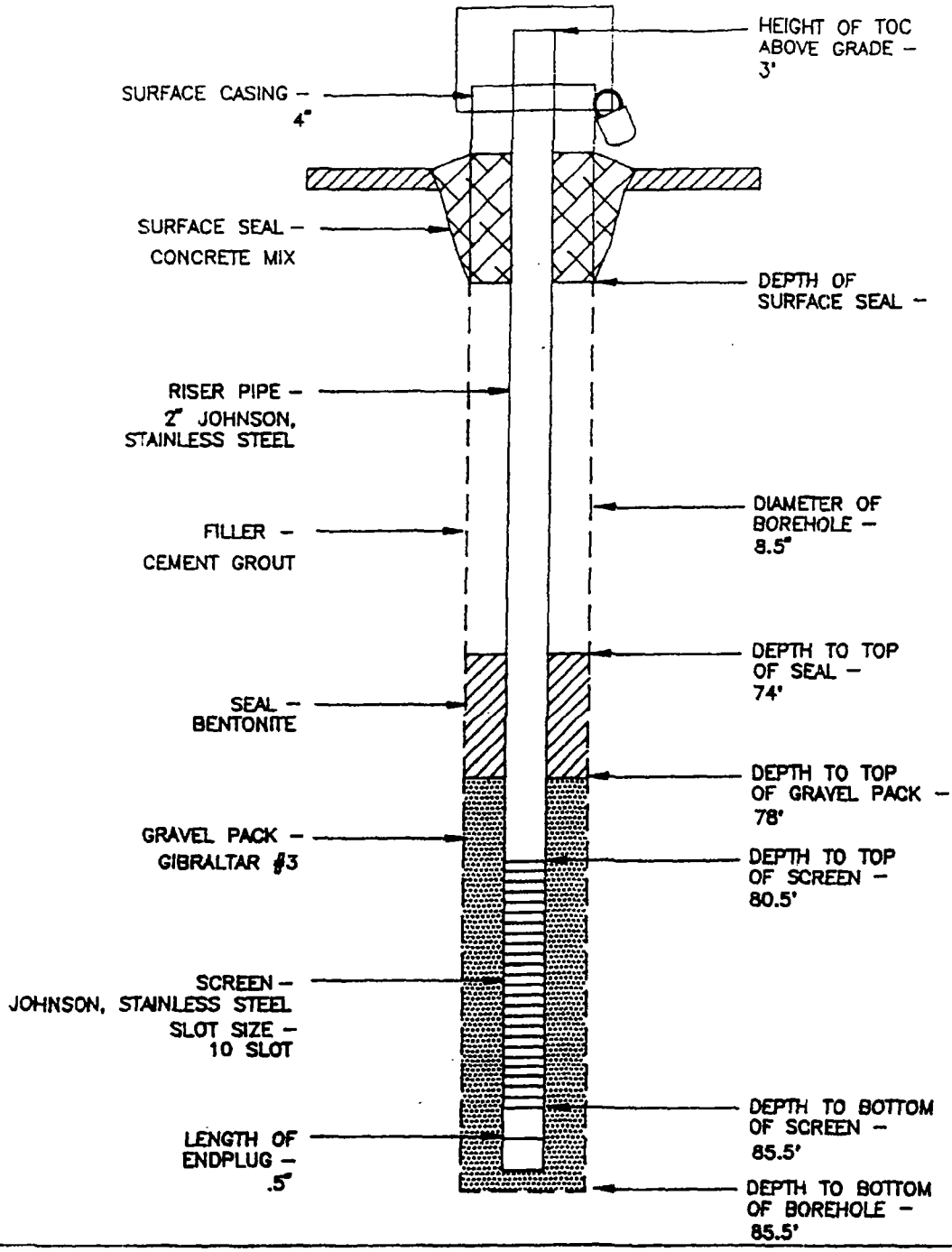


WELL NAME– MW–37	DATE COMPLETED– 9–18–90
SOIL BORING #–	TOC– 789.18'
DRILLER– STEARNS	GRADE– 786.6'
TECHNICIAN– D. LITTFIN	STATIC WL–

PROJECT NAME STREBOR, INC.			ENGR'G M.W.	DATE		BAY WEST, INC. ENVIRONMENTAL SERVICES ST. PAUL, MN.
TITLE MONITOR WELL CONSTRUCTION			DRAWN K.M.	11/2/90		
DWG NO. 1339–A1	SCALE NONE	FIGURE #	REV.			

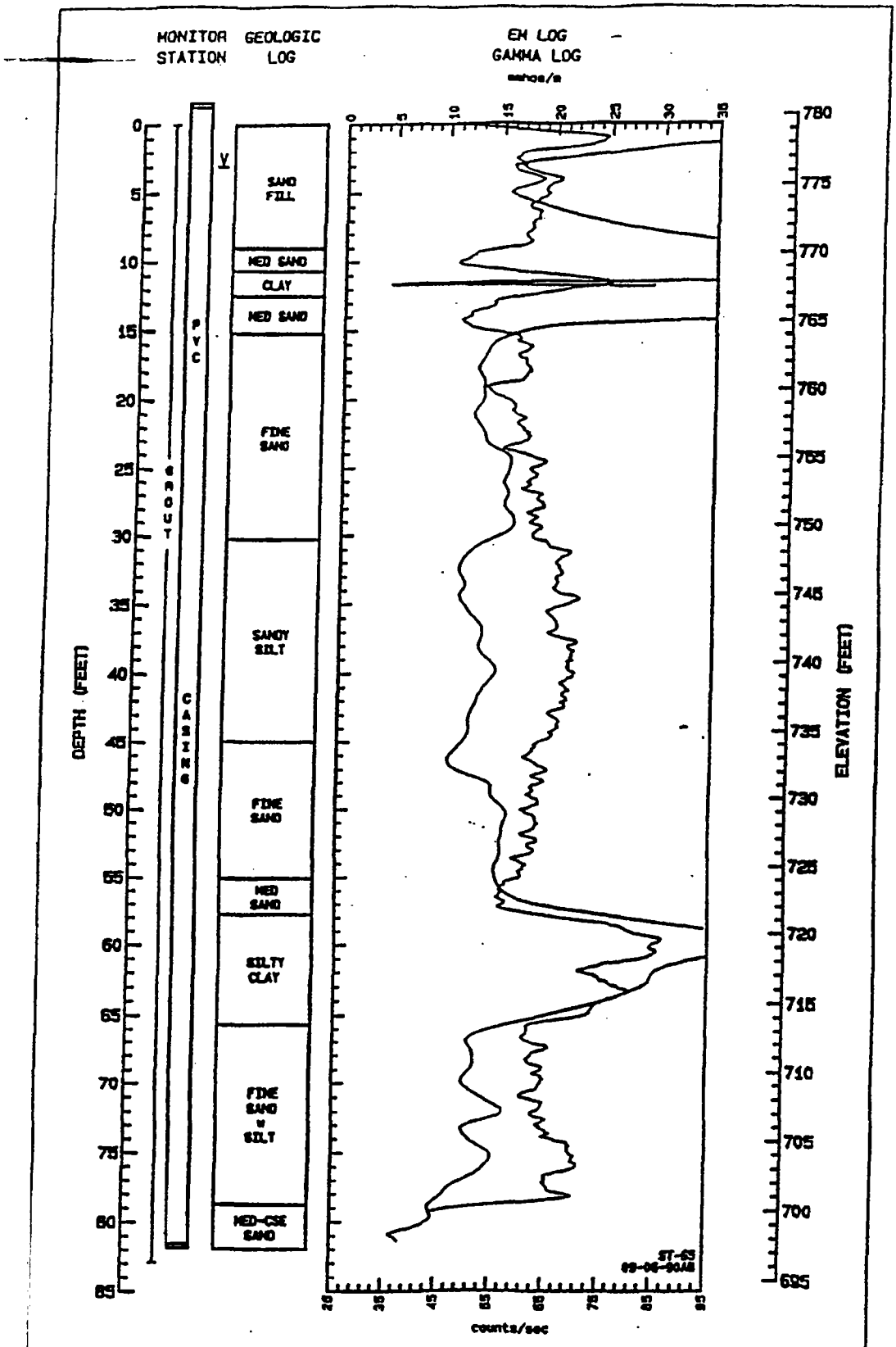


STREBOR SITE - GMS4 Kalamazoo, MI MW-37		GEOSPHERE, INC 9-08-90 Miami, Fla



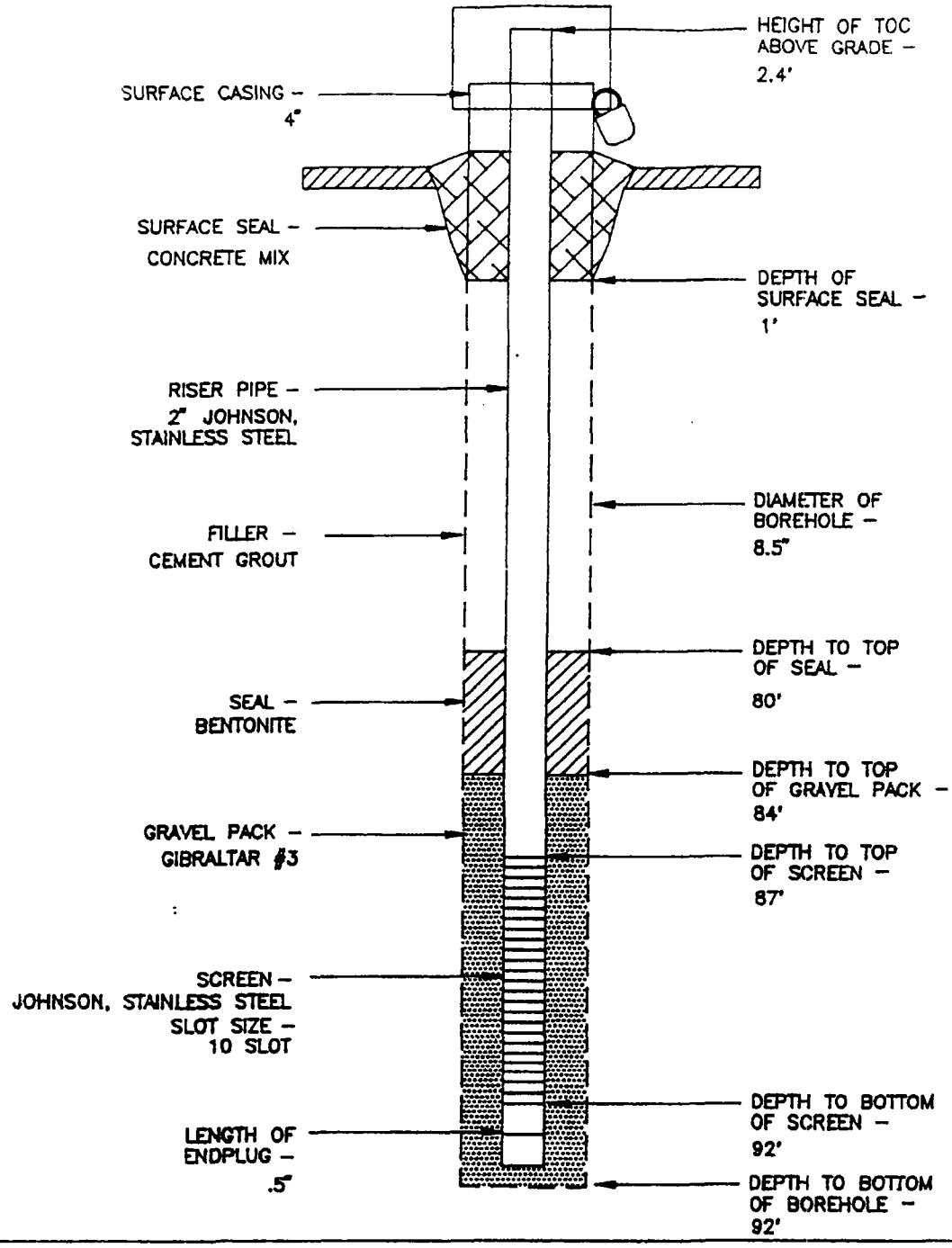
WELL NAME– MW–39	DATE COMPLETED– 9–20–90
SOIL BORING #–	TOC– 782.18'
DRILLER– STEARNS	GRADE– 779.2'
TECHNICIAN– D. LITTFIN	STATIC WL–

PROJECT NAME STREBOR, INC.			ENGR'G M.W.	DATE	BAY WEST, INC. ENVIRONMENTAL SERVICES ST. PAUL, MN.
TITLE MONITOR WELL CONSTRUCTION			DRAWN K.M.	11/2/90	
DWG. NO. 1339–A1	SCALE NONE	FIGURE #	REV.		



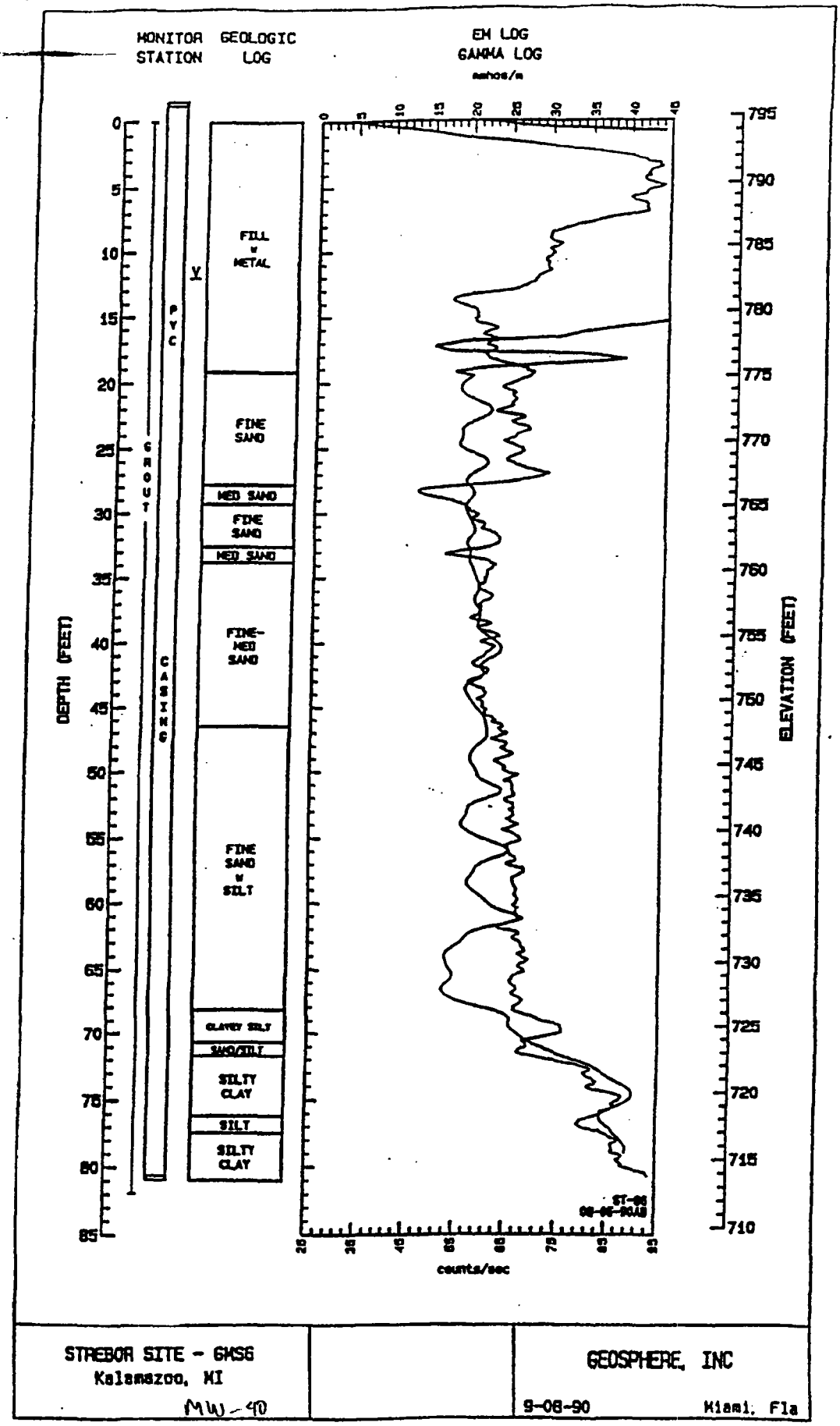
STREBOR SITE - GMS5
Kalamazoo, MI
MW-39

GEOSPHERE, INC
9-06-90 Miami, Fla



WELL NAME– MW–40	DATE COMPLETED– 9–20–90
SOIL BORING #–	TOC– 797.16
DRILLER– STEARNS	GRADE– 794.8
TECHNICIAN– D. LITTFIN	STATIC WL–

PROJECT NAME STREBOR, INC.			ENGR'G M.W.	DATE	BAY WEST, INC. ENVIRONMENTAL SERVICES ST. PAUL, MN.
TITLE MONITOR WELL CONSTRUCTION			DRAWN K.M.	11/2/90	
DWG. NO. 1339–A1	SCALE NONE	FIGURE #	REV.		



STREBOR SITE - GMS6 Kalamazoo, MI MW-90		GEOSPHERE, INC 9-06-90 Miami, Fla